Speculum Nauticum.

A

LOOKING GLASSE.

FOR

SEA-MEN:

Wherein they may behold a ſmall Inſtrument called the Plain SCALE: whereby all Queſtions Nauticall, and Propoſitions Aſtromicall are very eaſily and demonſtratively wrought.

Publiſhed for the uſe and benefit of ſuch as will make good uſe of it.

By *Iohn Aſpley*, Student in Phyſick, and Practitioner of the *Mathematicks*, in the Citie of *London*.

The third Edition corrected.

LONDON,
Printed by *Thomas Harper*, and are to be ſold by *George Hurlock*, at his ſhop at Saint *Magnus* corner.
1638.

C. 192. a. 55.

TO THE WORSHIPFVLL THE MASTER, WARDENS, and Aſſiſtants, of the *Trinitie Houſe* in *Deptford Strand*.

ALbeit (*Right Worſhipfull*) there be more eſſentiall natures contained in each part both of this *Macrocoſme*, and *Microcoſme*, exiſting in their abſolute being, than the underſtanding of man can fully apprehend; yet I doubt not, but thoſe which may with labour and diligence be known, and thoſe alſo which of ingenious ſpirits and notable wits have been invented, and by them artificially & methodically taught, (tending not onely to manifeſt profit in

the Common-wealth, but alſo to the great increaſe and ſetting forth of Gods divine power, wiſdome, goodneſſe, providence, and increaſe of Vertue) ought of all men to be embraced, (and eſpecially of thoſe which have any government, publike charge, or authority in the Common-wealth.) In regard that the neerer men approach to ſuch excellent Vertues, the neerer (without doubt) do they come unto goodneſſe, to felicity, and to God himſelf. Hence ſaith the Prophet (unto men ſeated in eminent places) *Dixi vos dii eſtis*, ſo that thoſe which either through arrogance, or ignorance deride, and contemne thoſe Arts (which with great dexterity, care, and induſtry have bin found out, and left unto us by the love of our Predeceſſors) do both offer contempt unto the goodneſſe of God, and do much endamage and annoy all humane ſociety. So on the contrary part, they that do by all means further thoſe ſo profitable

Diſ-

Diſciplines doe both render true honour unto GOD, and doe greatly advance the good of the Common-wealth wherin they live. Now in regard there is no ſtudy (Divinitie excepted) wherein the wit of man may be better employed than in the motion of the ſtars, and in the knowledge of their ſituation, place, and being, together with their wonderfull effects: In regard wherof I was incited to imploy ſome of my time in the ſtudie therof, and at laſt conſidering that of the Orator, that *Non ſolum nobis nati ſumus, &c.* We are not born for our ſelves onely, but our friends challenge a part in us, and our Countries come in for a ſhare, eſpecially thoſe honours and graces of our Countrey, *thoſe that trafique in the deepe, and have their buſineſſe in the great waters*, thoſe that are unto this Iſland as a wooden wall, the Sea-chariots, and the horſes of *England*: theſe, I ſay, may claime juſtly to the fruits of our labours, whatſoever

ſoever they be which have not altogether been abhorrent from the Mathematicall ſtudies: conſidering this, I could do no leſſe than bring in this my mite into their treaſury, and *Si quid Ars mea efficere poſsit*, (If my skill can ſtand them in any ſtead) to further that ſo much deſerving Science of Navigation. Accept therfore, I beſeech you, this yong ſonne of my ſtudies, this little handfull of paper, wherin is contained not *Anacreons* wanton Odes, or *Ovids* laſcivious Elegies, the incendiaries of luſt, but a pure ſpark of chaſt and Veſtal fire, a ſmall part of the Mathematicks dedicated from a ſerviceable affection to your Worſhips, that under the ſhield of your protections it may live ſecure, from the deſperate ſtab of criticall perſons, and envious ſpirits, who not onely like ſnarling *Satyres* deride and contemne thoſe ſo liberall Sciences, but ſwallow up with deſpite (if it were poſſible) the profeſſours therof.

For

For reſcue from ſuch malignant ſpirits my Book flies to the ſhadow of your favour, which if you ſhall afford unto it, my labours ſhall be all ſacrificed unto you, and I reſt

Your Worſhips bound ſervant,

IOHN ASPLEY.

To the Reader.

HAving ever ſince I came unto underſtanding (courteous Reader) practiſed my ſelfe in the Mathematicall ſtudies: and having attained unto my deſires therin, I am willing to impart ſome of that knowledge which God hath beſtowed upon mee, unto the open view of the World: for the manifeſtation wherof, I have freely given unto thee this ſmall Book, being the firſt fruit of my labours, containing ſuch Aſtronomicall and Nauticall Queſtions as are wrought by the plaine Scale: which if I ſhould finde to receive as free acceptance from thee, expect more of my labours in the ſame kinde, and untill then I reſt.

Thy friend in affection,

IOHN ASPLEY.

Speculum Nauticum.

OR THE

SEA-MANS GLASSE.

THE FIRST BOOK.

CHAP. I.

BEing intended in this Treatiſe of the plaine Scale, to declare the manner of projection of the Sphear, *in plano*, I have thought fitting firſt, to ſhew unto you ſome terms of *Geometry* which are neceſſary for the unlearned to know, (for whoſe ſake chiefly I write this Treatiſe) before they enter

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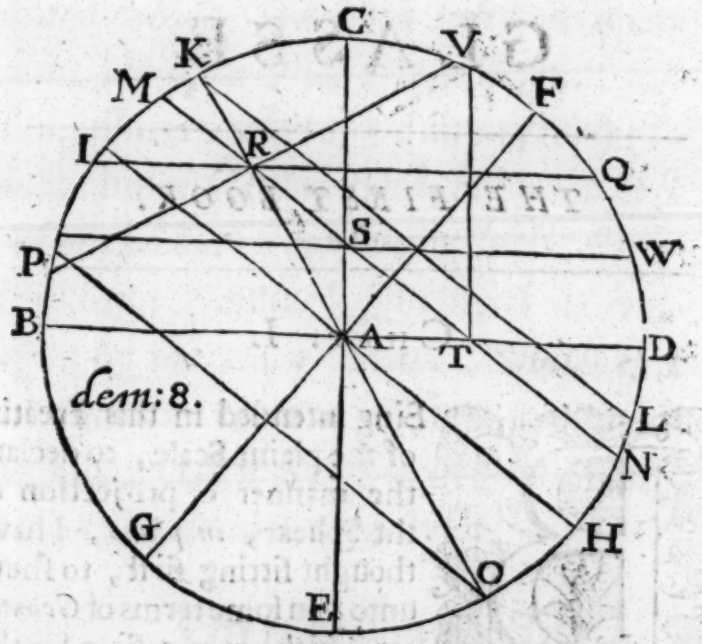
into the definition of the Sphear. First, therfore I intend to relate unto you, what a point or prick is, and afterward a Line both right and crooked, and such sorts thereof as are appertinent unto the operations and use of this Scale.

Punctum, or a point, is the beginning of things, or a prick supposed indivisible, void of length, breadth, and depth: as in the figure following is noted by the Point or Prick A.

Linea, or a Line is a supposed length, or a thing extending it selfe in length, not having breadth nor thickneſſe, as is set forth unto you by the Line B, A, D.



Parallela, or a Parallell Line, is a Line drawne by the side of another Line, in such sort that they may be

be equidiſtant in all places. And of ſuch Parallels, two onely belong unto this work of the plain Scale, that is to ſay, the right lined Parallell, and the circular Parallell.

Right lined Parallels are two right lines equidiſtant one from another, which being drawn forth infinitely, would never touch or meet one another, as you may ſee in the figure where the Line H. I. is Parallell unto the line C.E. and the line G.F. is Parallell unto them both.

A circular Parallell is a Circle drawn either within or without another Circle upon the ſame Centre, as you may plainly ſee by the two Circles B.C.D.E. and X.V.Y.W. Theſe Circles are both drawne upon the Centre A. and therfore are Parallell the one unto the other. There is another kinde of Parallell alſo, which is called a ſerpentine Parallell, but becauſe it is not belonging unto the uſe of this Scale, I will omit it and ſo proceed unto the reſt.

Perpendiculum, or a Perpendicular is a Line rayſed from, or let fall upon another Line, making equall angles on both ſides, as you may ſee declared in the figure, wherin the Line A. C. is perpendicular unto the line B.A.D. making equall angles in the point A.

Diameter Circuli, or the Diameter of a Circle, is a right Line drawn thorow the Centre of any Circle, in ſuch ſort that it may divide the Circle into two equall parts, as you may ſee the line B.A.D. is the Diameter of the Circle B.C.D.E. becauſe it paſſeth thorow the Centre A. and the two ends therof do divide the Circle into two equall parts, in the two extrems B. and D making the ſemicircle B.C.D. equall unto the ſemicircle D.E.B.

Semidiameter circuli, or the Semidiameter of a Cir-

cle, is half of the Diameter, and is contained betwixt the Centre, and the one side of the Circle, as the Line A.D. in the Semidiameter of the Circle B.C.D.E.

Semicirculus, or a Semicircle, is the one half of a Circle, drawne upon his Diameter, and is contained upon the Superficies, or Surface, of the Diameter, as the Semicircle B. C.D. which is halfe of the Circle B. C.D.E. and is contained above the Diameter B. A.D.

Quadrans circuli, is the fourth part of a Circle, and is contained betwixt the Semidiameter of the Circle, and a line drawne Perpendicular, unto the Diameter of the same Circle, from the Centre therof, dividing the Semicircle into two equall parts, of the which parts, the one is the quadrant, or fourth part of the same Circle. As for example, the Diameter of the Circle B.C.D.E. is the line B.A.D. dividing the Circle into two equall parts: then from the Centre A. raise the Perpendicular A. C. dividing the Semicircle likewise, into two equall parts, so is A.B.C. or A.C.D. the quadrant of the Circle B.C.D.E. which was desired.

CHAP.

Chap. II.

The manner how to raiſe a Perpendicular from the middle of a Line given.

DRaw firſt a ground line whereupon you would have a Perpendicular raiſed, then open your Compaſſes unto any diſtance (ſo it exceed not the end of your line,) placing one foot of the ſaid Compaſſes, in the point from whence the Perpendicular is to be raiſed, and with the other foot make a mark in the line on both ſides, then removing your Compaſſes, unto any other diſtance that is greater, and ſet one foot therof, in one of the marks, and with the other foot make a mark over the middle point, then with the ſame diſtance of your Compaſſe, ſet one foot in the other mark upon the Line, and with the other foot make another arch of a Circle over the middle point, ſo that it may croſſe the firſt arch, and from the meeting of theſe two arches, draw a right Line unto the middle point, from which the Perpendicular was to be raiſed, which Line ſhall be the Perpendicular deſired.

Example, ſuppoſe your Baſe or ground Line whereupon a Perpendicular is to be raiſed by the Line F. L. K. and from L. the Perpendicular is to be raiſed, ſet one foot of your Compaſſes in the Point L. and with the other, make the marks G. and M. on both ſides of the point L. then opening your Compaſſes wider, ſet one foot in the point M. and with the other draw the arch S. over the point L. then with the ſame diſtance of your Compaſſes, ſet on foot in G. and with

the other make the arch R. crossing the arch S. in the point T. then from T. draw the Line T. L. which Line is Perpendicular unto the Line F.L.K. from the point L. which is the Perpendicular desired.

Chap. III.

To let a Perpendicular fall from any Point assigned, unto the middle of a Line.

LEt the Line whereupon you would have a Perpendicular let fall, be the Line L.F.K. and the Point assigned, to be the Point T. from whence you would have a Perpendicular let fall upon the Line F. L. K. first set one foot of your Compasses in T. and open your Compasses unto any distance so that it be more than the distance T. L. which here wee suppose to be the distance T.M. then make in the Line F.L.K. the marks G. and M. then with your Compasses, take the one half of G. M. which is in the point L. then from L. draw a Line unto the point T. so the Line T. L. shall be the Perpendicular, which was desired to be let fall from the assigned Point T. unto the middle of the Line F.L.K.

Chap. IV.

To rayse a Perpendicular upon the end of a Line.

SVppose the Line whereupon you would have a Perpendicular raised, be the Line F. L. K. and from the Point F. a Perpendicular is to be raised: first open your Compasses unto any distance, which here wee put to be the distance F.G. and set one foot of your Compasses in the point F. and with the other draw the arch D.E.G. then set one foot of your Compasses in the point G. and with the other draw the arch E. then placing one Point of your Compasses in F. with the other draw the arch D.B. then place your Compasses in D. and with the same distance, draw the arch A. cutting the arch D.B. in C. then draw a Line from C. unto the end of the Line F.L.K. unto the assigned Point F. so shall the Line G.F. be a Perpendicular raised from the end of the Line F.L.K. and from the assigned Point F.

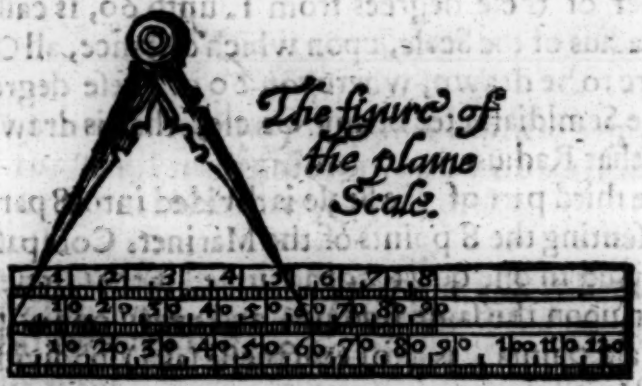
Chap. V.

To let a Perpendicular fall from any point assigned unto the end of a Line.

Set the Line F. L. K. be the Base or ground Line, and from the Point I a Perpendicular is to be let fall upon the end of the Line K. first from the assigned Point I. draw a Line unto any part of the Base, which shal be the Line I. H. M. then finde the middle of the Line I. M. which is at H, place therefore one foote of your Compasses in the Point H. and extend the other unto I. with which distance draw the arch I. N. K. upon the Centre H. cutting the Base or ground-line in the point K. then draw the Line K. I. which Line shal be the Perpendicular desired.

NOW I doubt not but you understand the way to let fall, or to raise, any manner of Perpendicular Line, either from, or upon any part of a Line: therfore now I intend to proceed unto the mayne point hereaymed at, which is, to declare, and make known unto you the severall operations performed by the plaine Scale, which though it be in use with very few, yet it is most necessary for Sea-men, because all questions in Navigation are therby easily and plainly wrought. And also all questions in Astronomy (belonging unto the expert, and industrious Sea-men) may both speedily and easily be wrought by the same Scale: in regard wherof I have declared in this little Book, that knowledge (which God hath been pleased

sed to bestow upon me) concerning the necessary use and practice therof; hoping that you will as kindly accept it, as it is freely offered unto your courteous considerations.



The figure of the plaine Scale.

Chap. VI.

Of the description of the Scale.

THis Scale usually is divided into three parts, the first whereof is a Scale of equall Leagues, divided into Degrees, or Leagues from 1 unto 100. and upwards, at your pleasure, and numbred with 10, 20, 30, 40. and so forth unto the end. All these divisions are equall one unto another, and is in use for to measure the leagues that any ship hath run upon any course, or the leagues that she hath raised or depressed the Pole, or departed the Meridian, as in the worke hereafter shall be more fully declared.

The second part of the Scale, is the single Corde

of a Circle, or the Corde of 90. and is divided into 90. unequall divisions, representing the 90. deg. of the Quadrant: and are numbred with 10, 20, 30, 40, &c. unto 90. This Corde is in use to measure any part, or arch of a Circle not surmounting 90. degrees: The number of these degrees from 1. unto 60, is called the Radius of the Scale, upon which distance, all Circles are to be drawn, whereupon 60 of these degrees are the Semidiameter of any Circle, that is drawne upon that Radius.

The third part of the Scale is divided into 8 parts, representing the 8 points of the Mariners Compasse, contained in one quarter of a Circle, if the Circle be drawn upon the same Radius, and every one of the aforesaid points, is (for exactnesse sake) subdivided into 8 smaller parts.

I have likewise caused two other lines to be placed upon the back side of the Scale, which I doe call the first and second Lines of Longitudes: the first is divided into 20 unequall parts, or leagues, which 20 Leagues are equall unto the Corde of 90. The use of this first Line of Longitudes, is to shew how many Leagues and Miles in any Parallell, doe answer unto one degree of the Equinoctiall.

The second Line of Longitudes is divided into 100 proportionable parts, or into 100 unequall leagues; and every league is subdivided into miles, and halfe miles. The use of this Line is thus: when you have found by the first Line of Longitudes, how many Leagues and Miles do answer unto a degree of the Equinoctiall in any latitude you desire: this second line will shew you how many degrees any number of leagues in that Parallell, will answer unto a degree in the Equinoctiall Circle.

Thus

Thus having ſhewed you the parts of the Scale, and unto what uſe they doe generally ſerve, I will proceed to declare the particular uſe thereof, in the Art of Navigation, as followeth.

CHAP. VII.

To finde how much any Ship hath raiſed or depreſſed the Pole, knowing the courſe ſhe hath made, and the leagues ſhe hath ſayled.

He Courſe is Southweſt and by South, the Leagues ſailed are 100. the difference of Latitude is demanded.

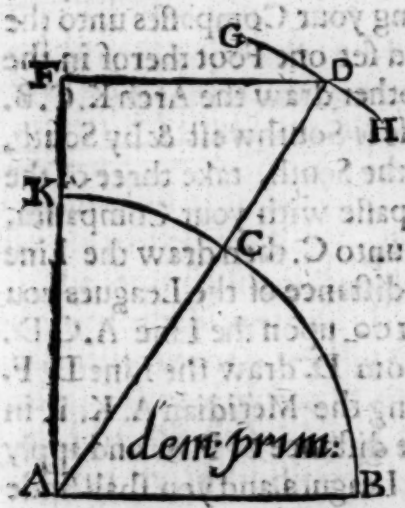
In the firſt Demonſtration, draw firſt the Line A.B. and upon the Centre A. raiſe a Perpendicular A.F. Then opening your Compaſſes unto the *Radius* of your Scale, and ſet one Foot therof in the Centre A. and with the other draw the Arch K.C.B. then in regard your courſe is Southweſt & by South, that is three points from the South, take three of the eight points of the Compaſſe with your Compaſſes, and place them from K. unto C. then draw the Line A.C.D. and place the diſtance of the Leagues you have ſayled (which) are 100. upon the Line A.C.D. from A. unto D. Then from D. draw the Line D.F. Parallell unto A.B. cutting the Meridian A.K.F. in the point F. then take the diſtance of F.A. and apply it unto the Scale of equall Leagues, and you ſhall finde it juſt 83. Leagues, or 4 Deg. 9. Min. which are the degrees you have altered the Latitude, which degrees and minutes (if the Latitude from whence you departed, be South) muſt be added unto the Latitude

from whence you departed, and you shall have the Latitude that you are in: contrariwise, substract them (if the Latitude from whence you departed, be North) and you have likewise the Latitude that you are in.

Chap. VIII.

The distance of Latitude and Leagues sailed being given, to find the distance Meridional, and consequently the difference of Longitude.

Saying from the North Parallell of 56. deg. and 5. min. 100. Leagues betwixt South and West, untill the Pole be depressed 4. deg. 9 min. the difference of Longitude is demanded.



IN the first demonstration draw the Quadrant A. K. C. B. as is taught in the last Chapter. Then reduce your degrees of Latitude into Leagues, which is done by multiplying of them by 20, the product will be 83 leagues, which leagues being applied unto the Meridian Line A. K. F. they will end in the point F. Then from F. draw the Line D. F. Parallell unto A. B. Then open your Compasses unto the distance of 100. leagues of your Scale of equall parts, and

and ſet one foot of your Compaſſes in the point A. and with the other draw the Arch G.H. cutting the Line F. D. in D. ſo ſhall the diſtance D. F. be the diſtance of the Meridian, from the Meridian, from whence you departed, which (being applyed unto the Scale) is 56 leagues. Then in regard you ſailed from the North Parallell of 56. deg. and 5 min. untill you had depreſſed the Pole 4. deg. 9. min. Subſtract the fore 4 deg. 9 min. from 56 deg. 5 min. and there remayneth 51 deg. 56. min. which is the latitude of the place you are in, and in that Parallell have you departed the firſt Meridian 56 leagues. Then opening your Compaſſes unto 51 deg. 56 min. of your Cord, and apply it unto the firſt Line of Longitudes, and you ſhall finde that 12 leagues and one mile (in that Parallell) do alter one degree of Longitude. Then ſet one foot of your Compaſſes in the ſecond Line of Longitudes, at 12 Leagues, one Mile, and extend the other unto one degree of that Line; then with that diſtance ſet one foot of your Compaſſes in 56 leagues of the aforeſaid Line, and the other will extend unto 4 degrees 33 min. which is the diſtance Meridionall deſired.

CHAP.

Chap. IX.

By distance of Latitude and distance Meridionall, given to finde the Rhombe.

Saying from the North Parallell 66 degrees: 20 min. untill the Pole be depressed four degrees and 9 min. and the distance Meridionall, or difference of Longitude, six degrees to finde the Rhombe is required.

By the first Demonstration, draw the Quadrant A. K. C. B. then turn your four degrees nine minutes into Leagues, it maketh eighty three Leagues; which place upon the line A. K. F. from A. unto F. then substract the difference of the two Latitudes, from the number of the first Latitude, and it leaves the second Latitude, 62 degr. 11. min. Then opening the Compasses unto the middle Latitude, which is sixty four degrees, and fifteen minutes of the Corde, applying it unto the first Line of Longitudes, and you shall finde eight Leagues, two miles, and four seconds to answer unto one degree: then set your Compasses in one degree, in your second Line of Longitudes, and extend the other foot unto eight Leagues, and two miles and foure seconds: then with that distance of the Compasses, place the one foot at six degrees of that line, and turn the other upward, and it will extend unto fifty six Leagues, therfore open your Compasses to the distance of fifty six Leagues, in the line of equall leagues, and apply them from the point F. upon the line F. D. parallell unto A B. from F. unto D. then from the point D. draw the

line

line D. A. cutting the Quadrant K. C. B. in C. so shall K. C. be the distance of the Rhombe from the South Westward, which is just thirty three degrees, forty five minutes from the South, which is Southwest and by South, the Rhombe desired.

Chap. X.

By the Latitude of two places, and distance upon the Rhombe to finde the leagues sailed.

The Pole depressed three degrees thirty minutes, the Rhombe the fourth from the Meridian.

IN the second Demonstration draw the line A. E. then from A. raise the Perpendicular A. C. then opening the Compasses to the distance of the Radius, placing one foot thereof in the Centre A. and with the other draw the Quadrant B. D. E. Then reduce your three degrees, thirty minutes into leagues, counting for every degree twentie Leagues, and for thirty minutes ten Leagues, so they make seventy Leagues; then open your Compasses unto seventy degrees in the line of equall parts, and place them upon the line A. B. C. from A. unto C. then from C. draw the line C. F. Parallell unto A. E. Then in regard your Rhombe was the fourth from the South, take foure of the eight points of the Compasse, and place them upon the

the Quadrant from B. unto D. then from A. by the point D. draw the line A. D. F. cutting the line C. F. in F. So shall the distance betwixt A. and F. be the number of leagues (upon the fourth Rhombe) before you can either raise or depresse the Pole three degrees thirty minutes, which is here found to be ninety nine Leagues.

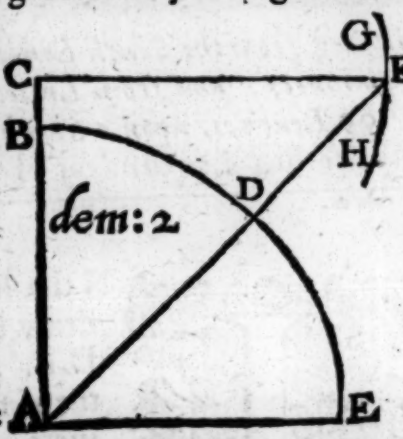
CHAP. XI.

To finde the distance of any Island from you, that you may discern by two Stations, knowing the point of the Compasse, the Island beareth unto each of the Stations.

Suppose (being at Sea) you discover an Island bearing Southwest of you, which place let it be your first Station, and seventy Leagues sayling South observing the Island to beare West of you, which let be the second Station, the demand is to finde the distance of the Island from both the Stations.

IN the second Demonstration let A. be the first Station, and upon the Centre A. draw the Quadrat A. B. D. E. then in regard you found the Island to beare South-west from you, therfore take four of your eight points of Compasse, and place them upon your Quadrant from E. unto D. then from the Centre A. by

by the point D. draw the Line A. D. F. representing the visuall Line passing betwixt your sight and the Island, being in the first Station. Then sayling seventy leagues South, which is from A. your first Station, unto C. the second Station: then observing the Island to beare West of you, therefore from the point C. the second Station, draw the Line



C. F. parallell unto A. E. cutting the Line A. D. E. in point F. so shall the point F. be the place of the Island desired, and the distance A. F. is the distance of the Island from the first Station, which is just ninety nine Leagues off the Line of equall parts. And likewise the distance from C. unto F. is the distance of the Island from the second Station, which is here found to be just seventy Leagues: and by this manner of work you may finde the distance of any Island from you, which you may discern either by Sea or Land.

Chap. XII.

Sailing from the South Longitude of 60 degrees, 51 minutes, and from Latitude 25 degrees, 24 min. 99 Leagues, upon a South-west course: the Latitude and Longitude of the second place is demanded.

IN the second Demonstration, draw the Quadrant A. B. C. D. E. as is formerly taught: then in regard you sail South-west, take four points of the Compasse from your Scale, and place them from B. unto D. then by the point D. draw the line A. D. F. then place your ninety nine Leagues upon the Line A. D. F. from A. unto F. so shall E. be the place of your Ship. Then from F. draw the Line F. C. parallell unto A. E. cutting the line A. B. C. in C. so let the distance C. A. be Leagues that you have run South, which is 70 Leagues, or 3 deg. 30 min. which being added to the latitude from whence you departed, makes sixty foure degrees and twenty one minutes for the Latitude of the second place: then take the distance C. F. and apply it unto the Line of equall parts, and you shall find it likewise seventie Leagues: then opening your Compasses unto the middle Latitude 62 degrees, 36 minutes in the Line of Cordes, and apply it unto the first Line of Longitudes, you shall finde that nine leagues and 0 miles, and 38 seconds, do alter a degree of longitude, then placing one foot of your Compasses in the second line of longitudes,

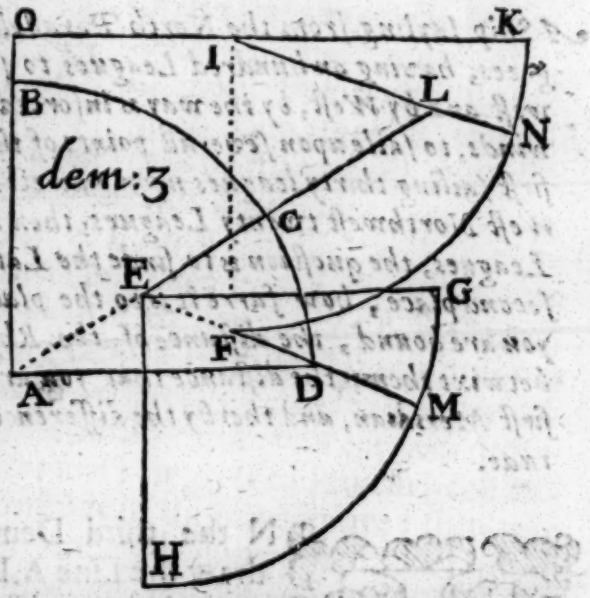
gitudes, at 9 leagues and thirty eight seconds, and extend the other to one, then keeping the distance of the Compasses, set one foot in the seventy leagues of the same line, and the other foot will extend unto 7 degrees 37. min. which being substracted from the longitude from whence you departed, leaves seventeen degrees, and forty seven minutes for the Longitude of the second place.

CHAP. XIII.

A Ship saying from the North Parallell of fifty degrees, having an hundred Leagues to saile South-west, and by West, by the way is inforced by contrary winds, to saile upon severall points of the Compasse, first sailing thirty leagues upon a direct course, then West Northwest twenty Leagues, then South sixtie Leagues, the question is to finde the Latitude of the second place, how farre it is to the place whereunto you are bound, the distance of the Rhombe that is betwixt them, the distance that you are from your first Meridian, and therby the difference of Longitude.

IN the third Demonstration, draw the Line A.D. and from the point A. raise the perpendicular A. B. then open your Compasses unto the Radius of your Scale, and place one foot therof in the centre A. & with the other draw the Quadrant B. C. D. then take three points of the Compasses, and

and place them upon the Quadrant from D. unto C. then from the Centre A, by the point C. draw the line A.C.L. 100 Leagues in length, which is the true course you are to saile. Then in regard you sayled 30 leagues direct, take thirty degrees from your Scale of equall parts, and place them upon the line A.E.C. extending from A. unto E. then in regard you turned your Course, West, Northwest, from the Centre E. draw the Line E. G. parallell unto A. D. and againe from the centre E. draw the line E.H. Perpendicular to E. G. and parallell to A. B. then with the distance of the Radius, set one foot of your compasses in the Centre E. and with the other draw the quadrant G. M. H. and in regard you sailed West, Northwest, which is 2 points from the West, Northward, take from your Scale two points of the Compasse, and place them upon the Quadrant G. M. H. from G. unto M. then from the Centre E. unto the point M. draw the line E.F.M. then take twenty leagues with your Compasses from the Scale of equal parts, and place them upon the line E. F. M. from E. unto F. then is your Ship in the point F. Lastly, in regard



gard you run South ſixtie Leagues, from F. draw a Line Parallell unto the Meridian A. B. which is the line F.I. then take from your Scale of equall parts 60 Leagues, and place them from F. unto I. then is your Ship in the point I. then laſt of all is to be found how far it is to the place wherunto you were bound, the diſtance of the Rhombe that is betwixt you, the degrees and minutes you have raiſed the Pole, the diſtance of departure from the firſt Meridian, and thereby the difference of Longitude, and that you may ſo do, firſt draw the Line O.I.K. Perpendicular unto the line I.F. in the point I. and with your Compaſſes opened unto the diſtance of the Radius, ſet one foot of your Compaſſes in the Centre I. and with the other draw the Quadrant K.N.F. then in regard your ſhip is in the point I. and the place wherunto you are bound in the point L. therfore from I, thorow the point L, draw the line I.L.N. cutting the Arch K.N.F. in the point N. therfore let I.L. be the Leagues you have unto the place wherunto you are bound, which is forty one Leagues and a half, and the Rhombe the diſtance K.N. which is Weſt, and by North, and three degrees unto the Northward, ſo likewiſe is the line A.O. the number of Leagues you have run due South, which is 68 Leagues and one Mile, or 3 degrees and 25 minutes, which being taken from 50 degrees, the parallell from which you departed, leaves 46 degrees and 35 minutes for the Parallell you are in. Laſt of all, ſhall the line I.O. be the Leagues that you have departed your firſt Meridian, which are 42 leagues and one mile: then open your Compaſſes unto 48 degrees 17 minutes and 30 ſeconds of the line of Cords, which is the middle Latitude, and apply it unto the firſt line of Longitudes, you ſhall finde that

13 Leagues 0. miles, fifty six seconds do answer unto a degree of Longitude in that Parallell, then setting one foot of your Compasses in 13 Leagues, and 56 seconds in your second line of Longitudes, extending the other unto one degree, then with the same distance of your Compasses, set one foot in 42 Leagues and one mile of the same line, and the other wil shew you 3 degrees and 13 minutes, which is the difference of the Longitude desired.

CHAP. XIV.

Two Ships departing from one Parallell, and Port, the one in sayling eight Leagues betwixt the North, and the West hath raised the Pole two degrees, the other in sailing a hundred Leagues betwixt the North, and West, hath raised the Pole four degrees, I demand by what Rhombes the said Ships have sailed, and the Rhombe, and distance that is betwixt them.

IN the fourth Demonstration, draw the Quadrant A. B. C. D. E. then in regard the first Ship hath raised the Pole two degrees, which is forty leagues, take forty leagues of your Scale, and apply them unto the Meridian line A. G. L. from A. unto G. then from the point G. draw the line G. F. parallell unto A. B. then opening your compasses unto 80 Leagues set one foot in the Centre A. with

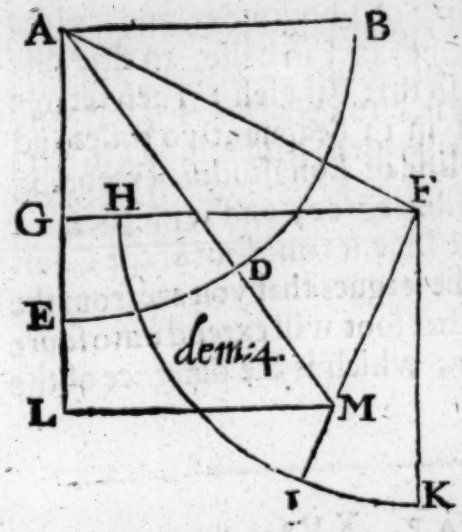
with the other, make a marke in the line G. F. which will bee at E. ſo ſhall F. bee the place of the firſt ſhip; the ſecond ſhip hath raiſed the Pole foure degrees, which is eighty Leagues, therefore place eightie Leagues upon the Meridian line A. G. L. from A. unto L. and from the point L. draw the line L. M. parallell unto G. H. F. then open your Compaſſes unto the diſtance of a hundred Leagues, which are the leagues the ſecond ſhip did run, and ſet the foot of your Compaſſes in the Centre A. and with the other make a mark in the line L. M. which will be at M. then draw the line M. A. which is the courſe of the ſecond Ship, and the line F. A. is the courſe of the firſt ſhip, then from F. let a Perpendicular fall, being Perpendicular to the line G. F. which is the line F. K. then opening your Compaſſes unto the Radius of your Scale, ſet one foot in the Centre F. and with the other draw the Quadrant H. I. K. likewiſe from F. the place of the firſt ſhip, draw a line by the point M. the place of the ſecond ſhip: cutting the quadrãt K. H. I. in I. ſo let I. K. be the courſe that is betwixt them, that is, if you will ſail from the firſt ſhip unto the ſecond, you muſt ſail North, and by Eaſt, and 41 minutes to the Eaſtward, likewiſe let F. M. be the diſtance that is betwixt them, which in this Demonſtration is 40 Leagues, two miles, ſo ſhall B. C. be the courſe of the firſt ſhip from the Weſt Northward, which here is found to be 30 degrees and one minute from the Weſt Northward, or Northweſt, by Weſt, and 3 degrees and 44 minutes to the Weſtward. Laſtly, the Arch E. D. is in the diſtance of the courſe that the ſecond ſhip made from the North Weſtward, which is found by this Demonſtration to be Northweſt, and by North, and three degrees five minutes to the Weſtward.

CHAP.

Chap. XV.

Two Ships departing from one Parallell and Port, in the Parallell of 47 degrees 56 minutes, the first in saying 80 Leagues betwixt the North and West, hath raised the Pole two degrees, I demand by what course the second ship must run, and how much shee shall alter in her first Meridian or Longitude, to bring her selfe 40 Leagues and two Miles North and by East, and forty one Minutes to the Eastward of the first ship.

IN the fourth Demonstration draw the Quadrant A.B.C.D. E. then multiply your two degrees, you have altered your latitude by twenty, and it maketh fortie Leagues; which fortie Leagues set upon the line A. E. L. from A. unto G. then from the point G. draw the line G. F. parallell unto A. B. then open your Compasses unto the distance of 80 Leagues, which are the leagues your first ship did run, and place one foot of your Compasses in the Centre A. and with the other make a mark in the line G. F. which will be at the point F. then from the Centre A. unto the point F. draw the line A. F. representing the distance of the course of the first ship 80 leagues: Then from F. let fall a perpendicular F.K. and upon the Centre F. upon the Radices of the Scale draw the Arch H.I.K. Then in regard you must bring the second ship North



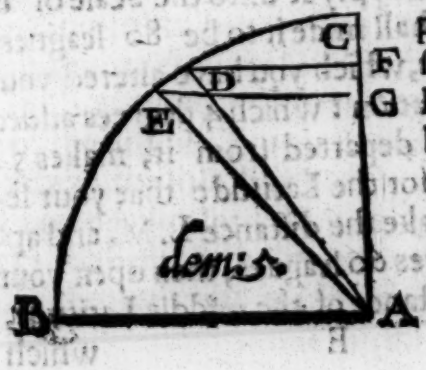
North and by Eaſt, and 41 minutes Eaſtward of the firſt ſhip, take 11 degrees, 56 minutes from your Scale of Coards, and place them from K. unto I. upon the Quadrant K. I. H. Then from F. draw the line I.F. and upon the line F.I. place the diſtance that you muſt bring the ſecond ſhip from the firſt (which is 40 leagues and two miles) from F. unto M. So is M. the place of your ſecond ſhip. Then from M. draw the line M.L. parallell unto F.G. cutting the line A. G. L. in L. then draw the line M.A. cutting the Quadrant B.D. E. in D. So ſhall the arch D.E. be the courſe that the ſecond ſhip muſt run, to bring her ſelf 40 leagues, and two miles North and by Eaſt, and 41 minutes Eaſt of the firſt ſhip. Then to know what you have altred the Latitude, firſt take the diſtance L. A. and apply it unto the Scale of equall parts, and you ſhall finde it to be 80 leagues, which is juſt 4 degrees, which you have altered your latitude, or Poles elevation: which 4 degrees added unto the Latitude you departed from it, makes 51 degrees, 56 minutes for the Latitude that your ſecond Ship is in, then take the diſtance L. M. and apply it to the Scale, it gives 60 leagues; then open your Compaſſes unto the diſtance of the middle Latitude,

which is 39 degrees, 51 minutes of the Coard, and apply it unto the first line of Longitudes, and it gives 12 Leagues, and two miles and an halfe, to alter one degree of Longitude in that Parallell: Then set one foot of your Compasses in 12 Leagues, two miles and an halfe in the second line of Longitudes, extending the other foot unto one degree, and with the same distance upon the same Line, set one foot of the Compasses in 60 leagues (the leagues that you are from the Meridian) and the other foot will extend unto foure degrees forty minutes, which is the differnce of the Longitude.

Chap. XVI.

To finde by Demonstration how many miles or minutes of any Parallell, doth answer unto one degree of the Equinoctiall.

LEt the Latitude given be 58 degrees 54 minutes, therefore having drawn the Quadrant A.B.C. from B. upon the Coard B.E.C. set the Latitude of the place 58 degrees 54 minutes unto the point D. Then from the point D. draw the line D. F. parallell unto B.A. So shall the length of the line D. F. be the number of miles which answer unto one degree of Longitude in the Parallell of 58 degrees 54 minutes, which being ap-



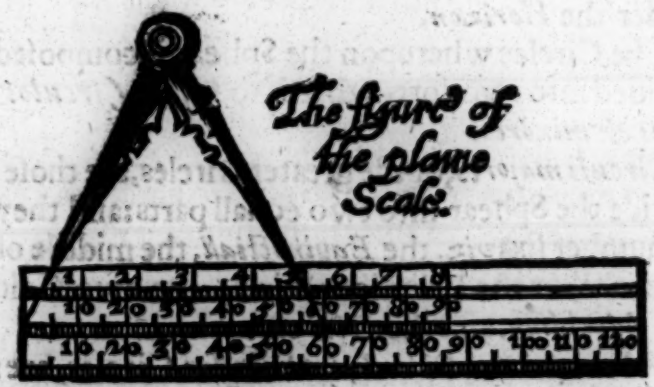
applyed unto your Scale of equall parts, gives thirty one miles. So likewise the Arke B.E. being the Latitude of 52 degrees, ending in the point E. give the lines E.G. For the miles that answer unto one degree of Longitude in the parallell of 52 degrees were found by the Scale to be 36 miles, and 56 seconds, or $\frac{56}{60}$ of a mile.

THE SECOND BOOK OF THE PLAIN SCALE, WHERIN

is declared the definition of the Sphear, *a description of the six great Circles, and also of the four lesser Circles, and last of all, certain Questions Astronomicall performed, by the said Scale.*

CHAP. I.

De Sphæra.



A *Sphear* according to the description of *Theodosius*, is a certain solid Superficies, in whose middle is a Point, from which all lines drawn unto the Circumference are equall; which Point is called the Centre of the Sphear, by which Centre a right Line being drawn, and extending himself on either

ther side unto that part of the Circumference wherupon the Sphear is turned, is called *Axis Sphæræ*, or the Axletree of the World.

A *Sphear* accidentally is divided into two parts, that is to say, *in Sphæram rectam, & Sphæram obliquam.*

Sphæra recta, or a right Sphear, is only unto those that dwell under the *Equinoctiall*, *Quibus neuter Polorum magis altero elevatur*: that is, to whom neither of the Poles of the World are seen, that lie hid in the *Horizon.*

Sphæra obliqua, or an oblique Sphear, is unto those that inhabit on either side of the *Equinoctiall*, unto whom one of the Poles is ever seen, and the other hid under the *Horizon.*

The Circles wherupon the Sphear is composed are divided into two sorts: that is to say, *in Circulos majores & minores.*

Circuli majores, or the greater Circles, are those that divide the Sphear into two equall parts: and they are in number six: *viz.* the *Equinoctiall*, the middle of the Zodiake, or the Ecliptique Line, the two Colures, the *Meridian*, and the *Horizon.*

Minores vero Circuli, or the lesser Circles, are such as divide the Sphear into two parts, unequally: and they are four in number: as the Tropick of *Cancer*, the Tropick of *Capricorn*: the Circle *Artike*, and the Circle *Antartike.*

CHAP.

Chap. II.

Of the four greater Circles.

He *Equinoctiall* is a Circle that crosseth the Poles of the World at right angles, and divideth the Sphear into two equall parts, and is called the Equinoctiall, because when the Sunne commeth unto it, (which is twice in the yeer, *viz. In principio Arietis, & Libræ*, that is, in *March* and *September*) the days and nights are equall thorowout the whole World, wherupon it is called, *Æquator diei & noctis*, the equall proportioner of the day and night artificiall: and in the figure is described by the Line C.A.E.

The *Meridian* is a great Circle, passing thorow the Poles of the World, and the Poles of the *Horizon*, or *Zenith* point over our heads, and is so called, because that in any time of the yeere, or in any place of the World, when the Sunne (by the motion of the Heavens) commeth unto that Circle, it is noon or 12 of the Clock. And it is to be understood, that all towns and places that lie East and West one of another, have every one a severall Meridian: but all places that lie North and South one of another, have one and the same Meridian. This Circle is declared in the figure following by the Circle B.C.D.E.

The *Horizon* is a Circle, dividing the superiour, *Hemisphere* from the inferiour, wherupon it is called *Horizon*, that is to say, the bonds of sight, or the farthest distance that the eye can see, and therfore it is also called *Circulus Hemisphæri*. The *Horizons* are divided into two sorts, *viz. Rectus & obliquus*, a right and

and an oblique, or a declining *Horizon*: whereof those have a right *Horizon* which have the *Equinoctiall* for their *Zenith*, and the Poles of the World in their *Horizon*: because the *Horizon* (hiding both the Poles of the World) is a Circle supposed to be drawn by the Poles of the World, dividing the *Equinoctiall* at right angles, as in the figure following you may plainly see. First, imagining the Circle X.V.Y.W. to be the earth, and those that inhabit at the Point V. have the line B.D. for their *Horizon*, cutting the *Equinoctiall* C.A.E. at right angles in A. and therefore is called *Horizon rectus & Sphera recta*, a right *Horizon*, and a right *Spheare*. Those have an oblique *Spheare*, or an oblique *Horizon* to whom one of the Poles are visuall, or elevated above the *Horizon*, and have the other hid under the *Horizon*, and in regard such a *Horizon* doth crosse the *Equinoctiall* at oblique angles, it is called *Horizon obliquus*, or a declining *Horizon*, as for example: Those that inhabit at the point S. have T. for their *Zenith*, and K.A.L. for their *Horizon*, dividing the *Equinoctiall* C.A.E. at oblique angles, making the angle contained betwixt the *Horizon* A.K. and the *Equinoctiall* A.C. an angle of thirtie eight degrees, and 28 minutes, and the angle contained betwixt the *Horizon* A.L. and the Pole A.D. an angle of 51 deg. 32 minutes, which is the elevation of the Pole for those that inhabit at S. those and all other have an oblique *Spheare*, except they inhabit just under the *Equinoctiall* Circle, unto whom onely doth a right Sphear belong.

Colurus Solstitiorum, or the Summer Colure is a Circle passing by the Poles of the World, and by the Poles of the Ecliptique, and by the head of *Cancer*

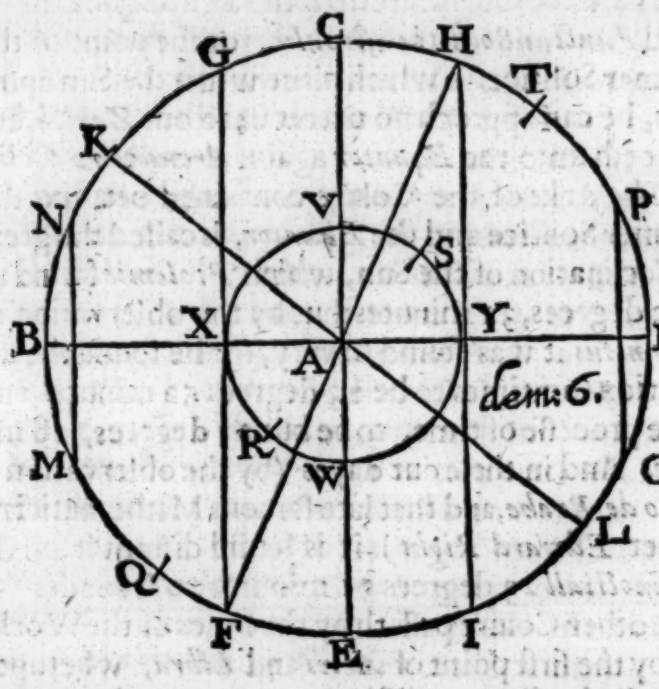
and

and *Capricorn*, whereupon the first scruple of *Cancer* where the Colure crosseth the Ecliptique Line, is called *Punctus Solstitia æstivalis*, or the point of the Summer Solstice: to which place when the Sun commeth, he can approch no neerer unto our *Zenith*, but returneth unto the *Equator* again. *Arcus vero Coluri*, The Arke of the Colure contained betwixt the Summer Solstice and the *Equator*, is called the greatest declination of the Sun, which *Ptolemie* found to be 23 degrees, 31 minutes: but by the observation of *Copernicus* it was found to vary, for he found the declination somtimes to be 23 degrees 52 minutes, and in the processe of time, to be but 23 degrees, 28 minutes. And in these our dayes (by the observation of *Tycho de Brahe*, and that late famous Mathematician, Master *Edward Right*) it is found distant from the *Equinoctiall* 23 degrees 31 minutes 30 seconds.

The other Colure passeth by the Poles of the World, and by the first point of *Aries* and *Libra*, wherupon it is called, *Colurus distinguens Equinoxia*. These two Colures doe crosse each other at right angles in the Poles of the World, wherupon these Verses were made.

Hæc duo Solstitia faciunt Cancer, Capricornus,
Sed noctes æquant Aries & Libra diebus.

The Zodiack is another of the greater Circles, dividing the *Equinoctiall* into two equall parts, by the head of *Aries* and *Libra*, the one halfe of it doth decline unto the North, the other into the South, the greatest of which declination is 23 degrees, 31 minutes, and 30 seconds. Note also, this Circle is divided into 12. equall parts, which parts are attributed



unto the 12 Signes, *Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagitarius, Capricornicus, Aquarius, & Pisces.* And every one of these Signes are divided into 30 equal parts, which are called degrees, so the whole Zodiake containeth 160 degrees. Likewise every degree is divided into 60 equall parts, which parts are called minutes, and are in number 21600 minutes, and as 21600 minutes is the whole circumference of the Heavens, so is 21600 miles the whole circuit of the Earth.

CHAP.

Chap. III.

Of the foure lesser Circles.

THe Sunne having ascended unto his highest Solstitiall Point doth describe a Circle, which is the neerest that he can approach unto the North Pole, wherupon it is called, *Circulus Solstitii æstivalis*, the Circle of the Summer Solstice, or the Tropick of *Cancer*, and is noted in the figure before, by the line H.Y.I.

The Sunne also approching unto the first scruple of *Capricornus*, or the Winter Solstice, describeth another Circle, which is the utmost bounds that the Sun can depart from the Equinoctiall Line towards the Antartike Pole, wherupon it is called, *Circulus Solstitii hyemalis, sive Tropicus hyemalis, vel Capricorni:* the Circle of the Winter Solstice, the Winter Tropick, or the Tropick of *Capricorn*, and is described in the figure by the Line G.X.F.

So much as the Ecliptick declineth from the Equinoctiall, so much doth the Poles of the Ecliptick decline frō the Poles of the World, wherupon the Pole of the Ecliptick, which is by the North Pole of the World, describeth a certain circle as it passeth about the Pole of the World, being just so farre from the Pole as the Tropick of *Cancer* is from the Equator, and it is the third of the lesser Circles, and is called, *Circulus Arcticus*, or the Circle of the North Pole, and is described in the *Diagram*, in the second Chapter by the Line P.O.

The fourth and last of the lesser Circles, is described in like manner, by the other Pole of the Ecliptick, about the South Pole of the World, and therfore

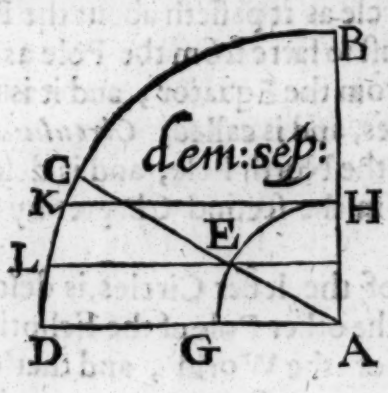
called *Circulus Antarcticus*, the Antarctick Circle, or the Circle of the Antarctick or South Pole, and is demonstrated in the former figure, by the line N.M.

Certain questions Astronomicall performed by the plain SCALE.

CHAP. IV.

The true place of the Sun, given to finde his declination.

THe Sun being in the head of *Taurus*, his declination is desired: by the seventh Demonstration, draw the line A.D. then upon the Centre A. raise the Perpendicular A.B. then opening your Compasses to the Radius of your Scale, and place one foot in the Centre A. and with the other draw the Quadrant B.C.D. then opening your Compasses unto the greatest declination of the Sun, and place it upon the Quadrant from D. unto K. then from the point K. draw the Line K.H. cutting the line A.B. in H. then with the distance A.H. draw the small Quadrant G.E.H. and in regard the Sunne is in the head of *Taurus*, which is thirty degrees from the beginning of *Aries*, let A.D. be the Equator, and



and D. the beginning of *Aries*, D.C. 30 degrees, or longitude of the Sunne, then from the point C. draw the line C.A. cutting the Quadrant G.E.H. in E. then from E. draw the line E.L. parallell to A.D. cutting the Quadrant B.C.D. in L. so shall the arch L.D. be the declination of the Sun desired, which in this demonstration is found to be 11 deg. and 31 minutes.

CHAP. V.

The declination of the Sun, and quarter of the Eclipse that he possesseth being given, it is desired to finde his true place.

The declination is 10 *degrees* 31 *minutes, the first quarter that he possesseth, is betwixt the head of* Aries *and* Cancer.

FIrst by the seventh Demonstration, draw the Quadrant A.B.C.D. as is taught in the former Chapter, then set the greatest declination of the Sun upon the Cord from D. unto K. which is 23 deg. and 31 minutes, then from K. draw the line K.H. parallell unto the *Equator* D.A. cutting the line B.A. in the point H. So shall H.A. be the signe of the Suns greatest declination, then with the distance A.H. draw the Circle, G.E.H. then from D. upon the Coard D.B.C. set the declination of the Sun, which is 11 degrees, 31 min. from D. unto L. then draw the line L.E. parallell unto A.D. cutting the Quadrant G.E.H. in E. Then from the Centre A. by the point E. draw the line A.E.C. cutting the Quadrant B.C.D. in C. So shall the arke

C. D. be the distances of the Sunne from the head of *Aries*, which is here found to be just 30 deg. which is in the beginning of *Taurus*.

CHAP. VI.

By the elevation of the Pole, and declination of the Sun, to finde the amplitude of the Sun, or his true rising, or setling from the East or West point.

BY the eighth Demonstration, first draw the line B. D. then upon the Centre A. draw the Circle B.C.D. E. then from A. raise the perpendicular C.A.E. then is your Circle divided into foure equall parts: then suppose the elevation of the Pole to be 51 deg. 32 min. which must be placed upon the Circle, from D. unto F. then from the point F. by the Centre A. draw the line F. A. G. representing the Pole of the World F. being the North Pole, and G. the South Pole, then substract 51 deg. 32 min. from 90 deg. and the remainder is the height of the Equinoctiall, which is 38 deg. 28 min. which must be placed upon the Circle from the Horizon B. unto the point I: then from I. by the Centre A. draw the line I. A. H. representing the Equinoctiall Circle. Then from I. unto M. set the declination of the Sun, being here supposed 14 deg. 52 min. North, then from the point M. draw the line, or Parallell of declination M. T. N. parallell unto the *Equator* I. A. H. cutting the Horizon B. D. in T. then from T. raise the perpendicular T. V. cutting the Circle B. C. D. E. in V. so shall the distance C. V. be the true amplitude of the Sunne desired, which here is found to be 24 deg. 21 min. North.

CHAP.

Chap. VII.

By the Amplitude of the Sun to finde the Variation of the Compasse.

HAving found the amplitude of the Sun by the last Chapter, first observe with a Compasse, or rather with a Semicircle upon what degree and minute the Sun riseth or setteth, beginning to reckon from the East or West, & ending at the North or South at 90 degrees: and when you have diligently observed the Magneticall rising or setting, by the Semicircle, or by some other like fitting Instrument: and also the true amplitude found, as is declared in the last Chapter, the difference of these two amplitudes, is the variation of the Compasse: But when the Sunne riseth upon the same Degree of the Compasse, as is found by the Scale, the variation is nothing, but the Needle pointeth directly unto the Poles of the World, which by Master *Mulinux* was affirmed to be at the Westernmost part of Saint *Michaels*, one of the Islands of the *Azores*, from whence hee will have the Longitude reckoned. Secondly, when the Sunne is in the *Equinoctiall* Circle, where hee hath no amplitude, looke what distance the Compasse maketh the Sun to rise from the East or West of the Compasse, the same distance is the Compasses variation, from the North or South. Thirdly, if the Sunne rise more to the South of the Compasse, or setteth more to the North by the Compasse, than is shewed by the Scale, the difference betwixt the amplitude given by the Scale, and the ampli-

amplitude given by the Needle, is the Variation of the Compasse from the North Westward. Fourthly, if the Compasse sheweth the Sun to rise more Northward, or set more Southward, than is shewed by the Scale, the difference is the variation of the Compasse, from the North Eastward. Fifthly, if the Scale shew the amplitude of the Sunne rising Southerly, and the Compasse shew it to be Northerly, adde both the Amplitudes together, and they shew you the variation Westerly.

CHAP. VIII.

The place of the Sun being given, to finde his declination by a whole Circle.

ACcording unto the right Demonstration, first draw the Circle B.C.D.E. then draw the Horizon B.A.D. and then the *Equinoctiall* I.A.H. as is before taught: and then the Tropick of *Cancer* K.L. 23 degrees and a half from the *Equinoctiall*: then draw the Tropick of *Capricorn* P.O. of like distance from the *Equinoctiall*, and after from K. to O. draw the Ecliptique Line K.A.O. And when you have thus laid down the Sphear, suppose the Sun to be in the tenth degree of *Taurus*, at which time his declination is desired. And in regard the Sunne is more neere unto the Tropicall point *Cancer*, then unto *Capricorn*; first finde how many

many degrees he is from the Tropick of *Cancer*, and you shall finde him to be 50 degrees; therefore take with your Compasses 50 degrees from the Coard, and apply it from the Tropicall point *Cancer* at K. unto V. upon one side, and unto P. on the other side: then draw the line V.P. cutting the Ecliptick K.O. in the point R. then from R. draw the Line M.R.N. parallell unto the Equinoctiall I. A. H. and cutting the Quadrant B.C. in the point M. So shall the Arke M. I. be the declination of the Sun desired, which being applyed unto your Scale, gives you 14 degrees and 52 minutes.

CHAP. IX.

The elevation of the Pole, and declination of the Sun, given to finde his height in the verticall Circle.

The Pole is elevated 51 deg. 32 minutes, the declination of the Sun is 14 degrees 52 minutes North, his height in the verticall Circle is found as followeth.

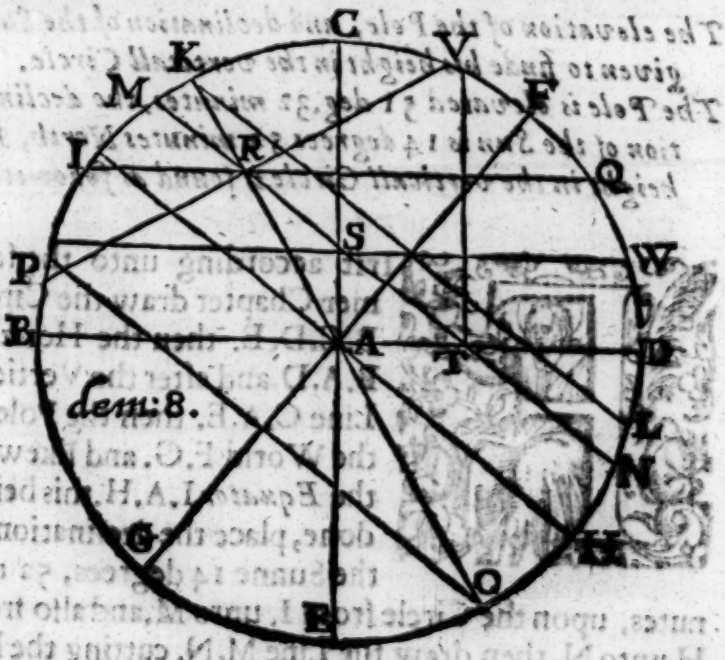
FIrst according unto the former Chapter draw the Circle B.C.D.E. then the Horizon B.A.D. and after the Verticall Line C.A.E. then the Pole of the World F.G. and likewise the *Equator* I.A.H. this being done, place the declination of the Sunne 14 degrees, 52 minutes, upon the Circle from I. unto M. and also from H. unto N. then draw the Line M.N. cutting the line

C.A.E. in S. then from S. draw the Line S.W. Parallell unto the Horizon B.A.D. cutting the Meridian Circle B.C.D.E. in W. So shall the distance D.W. be the height of the Sun in the verticall Circle, for the time demanded; which by this proposition is found to be 19 degrees and 8 minutes.

CHAP. X.

The elevation of the Pole, and the Amplitude of the Sun, being given, to finde the declination.

The elevation of the Pole is 51 deg. 32 min. the Sunne Amplitude is 24 deg. 21 minutes, the declination is found as followeth by the eighth Demonstration.



dem: 8.

First,

FIrſt, upon the Centre A. draw the Circle B. C. D. E. then draw the Line B. A. D. repreſenting the Horizon: dividing the Circle into two equall parts, then draw the Line C. A. E. perpendicular to B. A. D. repreſenting the Eaſt & Weſt point of the Compaſſe, then placing the elevation of the Pole 51 degrees, and 32 minutes, from D. unto F. from F. by the Centre A. draw the Line F. A. G. which let be the Pole or Axletree of the World, then from B. unto I. and from D. unto H. ſet the complement of the Poles elevation: which ſhall repreſent the Equinoctiall, in regard it maketh right angles with the Pole of the World, in the Centre A. Then from C. unto V. place the amplitude of the Sun, which is 24 degrees, and 21 minutes: then from V. let fall the Perpendicular V. T. cutting the Horizon B. A. D. in the point T. then from the point T. draw the Line M. T. N. Parallell unto the Equinoctiall I. A. H. & cutting the Circle B. C. D. E. in the point M. and N. ſo let the diſtance of I. and M. or H. and N. be the declination of the Sunne, which was deſired: which being applyed unto your Scale, giues you 14 degrees, and 52 minutes.

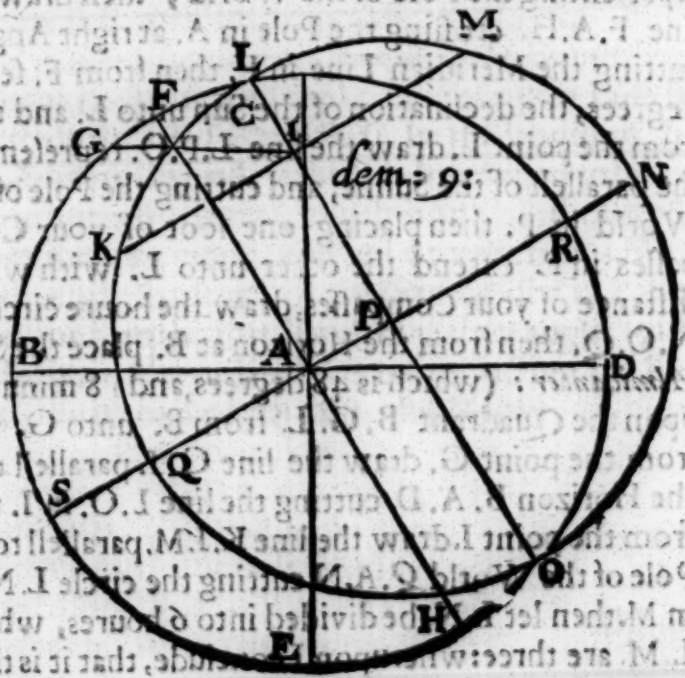
Chap. XI.

The elevation of the Pole, the declination of the Sunne, and houre of the day being given to finde the Almicanter is desired.

The elevation of the Pole is 30 degrees the declination of the Sun is 20 degrees North, the houre is nine in the morning, at which time the Almicanter is found, as followeth.

BY the ninth Demonstration, first upon the centre A. draw the circle B.C.D.E. then draw the Line B.D. for the Horizon, then place your Poles elevation which is 30 degrees upon the circle from D. unto R. then from R. by the centre A. draw the Line R.A.S. representing the Pole of the World, then from B. unto F. place the Complement of the Poles elevation, which is 60 degrees, and from the point F. by the Centre A. draw the line F.A.H. representing the Equinoctiall Line, and then set the declination of the Sun from F. unto L. and from L. draw the Line L.P.O. parallell unto the *Equator* F.A.H. cutting the Pole of the World in the point P. then set one foot of your Compasses in the point P. and extend the other either unto L. or unto O. and with the same distance of your Compasses, upon the centre P. draw the circle L.N.O.Q. which is called the houre circle, so shall L. be the point of 12 a clock at noone, N. the place of six a clock afternoon, O the place of 12 a clock at midnight, and Q. the place of six a clock in the morning: Every one of the four quarters, must be

be divided into six equall parts, or houres, making the whole circle to contain 24. parts, representing the 24 houres of the day and night, then in regard the hour of the day was 9 of the clock, which is 3 hours fore noon, take three of those 24 houres, and place them upon the circle L, N, O, Q. from the Meridian point L. unto K. the nine a clock point in the morning, and unto M. the point of three a clock after noon, then draw the line M.K. cutting the parallell of the Sun L.O. in the point I. then from I. draw the line I.G. parallell unto the Horizon B. A. D. which shall cut the Meridian circle B.C.D.E. in the point G. so let the distance of G, and B. be the Almicanter of the Sun which was desired, which in this Demonstration is found to be 48 degrees and 18 minutes.



CHAP.

Chap. XII.

The elevation of the Pole, the Almicanter, and declination of the Sun, being given to finde the houre of the day.

The elevation of the Pole is 30 degrees, the declination of the Sun is 20 degrees, the Almicanter of the Sun is 48 degrees, and 18 minutes, the houre of the day is found as followeth, by the ninth Demonstration.

First, upon the centre A. draw the circle B. C.D.E. then draw the Diameter B.D. representing the Horizon, then from D. unto R. set 30 degrees, the elevation of the Pole, then from R. by the Point A. draw the line R.A.S. representing the Pole of the World, then draw the line F.A.H. crossing the Pole in A. at right Angles, cutting the Meridian Line in F. then from F. set 20 degrees, the declination of the Sun unto L. and then from the point L. draw the line L.P.O. representing the parallell of the Sunne, and cutting the Pole of the World in P. then placing one foot of your Compasses in P. extend the other unto L. with which distance of your Compasses, draw the houre circle L. N.O.Q. then from the Horizon at B. place the Suns *Almicanter:* (which is 48 degrees, and 18 minutes,) upon the Quadrant B.G.L. from B. unto G. then from the point G. draw the line G.I. parallell unto the Horizon B.A.D. cutting the line L.O. in I. then from the point I. draw the line K.I.M. parallell to the Pole of the World Q.A.N. cutting the circle L.N.O. in M. then let L.N. be divided into 6 houres, wherof L.M. are three: whereupon I conclude, that it is three houres from noon, that is, at nine a clock in the morning, or three in the afternoon.

Chap.

CHAP. XIII.

The Almicantar, or height of the Sun being given, to finde the length of the right shadow.

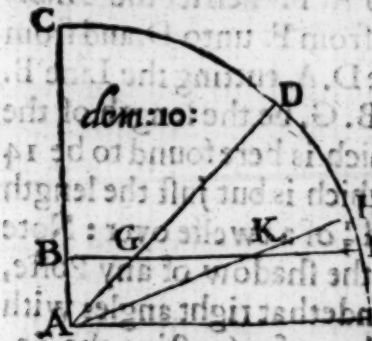
According unto the tenth Diagram, draw the Line A. F. and upon the centre A. raise the perpendicular A. C. then upon the centre A. draw the Quadrant C. D. F. then suppose the height of your *Gnomon*, or substance yielding shadow be the Line A. B. which is to be divided into 12 equall parts, which *Gnomon* I have here made just 12 degrees of the equall League of the Scale, then from B. to the top of the *Gnomon* draw the Line B. E. parallell unto A. F. then set the *Almicantar* which is 45 degrees from F. unto D. and from the point D. draw the Line D. A. cutting the Line B. E. in the point G. so shall B. G. be the length of the right shadow desired, which is here found to be 14 degrees and 18 minutes, which is but just the length of your *Gnomon*, and $\frac{2}{12}$ and $\frac{1}{3}$ of a twelfe over: Note that the right shadow, is the shadow of any Poste, Staffe, or Steeple, that standeth at right angles with the Horizon, the one end thereof respecting the Zenith of the place, and the other the *Nadir*.

CHAP.

CHAP. XIV.

The Almicanter, or height of the Sun being given to finde the length of the contrary shadow.

BY the verse or contrary shadow, is understood the length of any shadow, that is made by a Staffe or *Gnomon*, standing against any perpendicular wall, in such a manner that it may lie parallell unto the Horizon, the length of the contrary shadow, doth increase as the Sunne riseth in height: whereas contrariwise the right shadow doth decrease in length, as the Sun doth increase in height. The way to finde the verse shadow is as followeth. First, draw your Quadrant as is taught in the last Chapter, wherin let B. B. be the length of the *Gnomon*, likewise from B. draw the line B. E. parallell unto A. F. as before, then set your *Almicanter* from C. upon the Quadrant which is given to be 70 degrees, and it will extend from C. unto H. then from the point H. draw the line H. A. cutting the line B. E. in the point K. so shall K. B. be the length of the contrary shadow, which here is found to be 34 degrees and 8 min., or twice so long as your *Gnomon*, and $\frac{1}{13}$ and about $\frac{1}{3}$ part of a twelfth more.



CHAP.

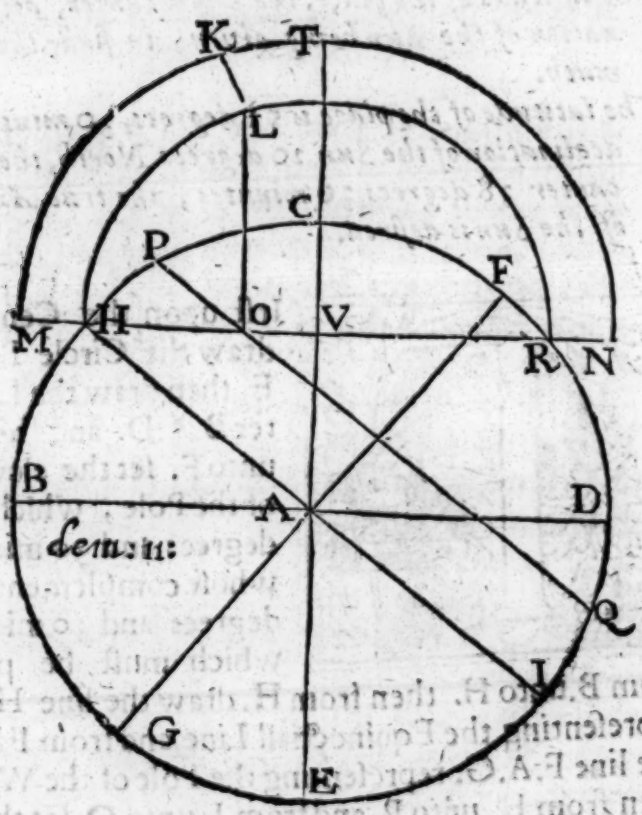
Chap. XV.

The latitude of the place, the Almicanter, and declination of the Sun being given, to finde the Azimuth.

The latitude of the place is 51 degrees, 30 minutes, the declination of the Sun 20 degrees North, the Almicanter 38 degrees 30 minutes, the true Azimuth of the Sun is desired.

First upon the Centre A. draw the Circle B.C.D. E. then draw the Diameter B.A.D. and from D. unto F. set the elevation of the Pole, which is 51 degrees, and 30 minutes, whose complement is 38 degrees and 30 minutes, which must be placed from B. unto H. then from H. draw the line H.A.I. representing the Equinoctiall Line, and from F. draw the line F.A.G. representing the Pole of the World, then from H. unto P. and from I. unto Q. set the declination of the Sun, which is 20 degrees, and by those two points draw the line P.Q. for the Parallell of the Suns declination; then upon the Circle from B. unto H. set the Suns Almicanter, 38 degrees, and 30 minutes, then from H. draw the line H.R. parallell unto the Horizon, cutting the Suns Parallell P.O. Q. in O. then draw the line T.V.A.E. Perpendicucular unto the line B.A.D. in the Centre A. and cutting the line H.V.R. in V. then set one foot of your

Compasses in the point V. extend the other unto R. and with the same distance draw the Semicircle H.



L. R. then draw the Concentrick Circle upon the Radius of the Scale M. T. N. and where the line P. O. Q. and the line M. O. N. do meet in the point V. raise the Perpendicular O. L. cutting the Semicircle H. L. R. in L. then lay the Scale from the Centre N. to the point L. and draw the Line I. K. cutting the Semicircle M. T. N. in K. so shall K. T. be the true distance of the Sun, from the East, or West point Southward, or

the

the Suns true Azimuth, which is here found to be 72 degrees, and 40 minutes from the South part of the Meridian.

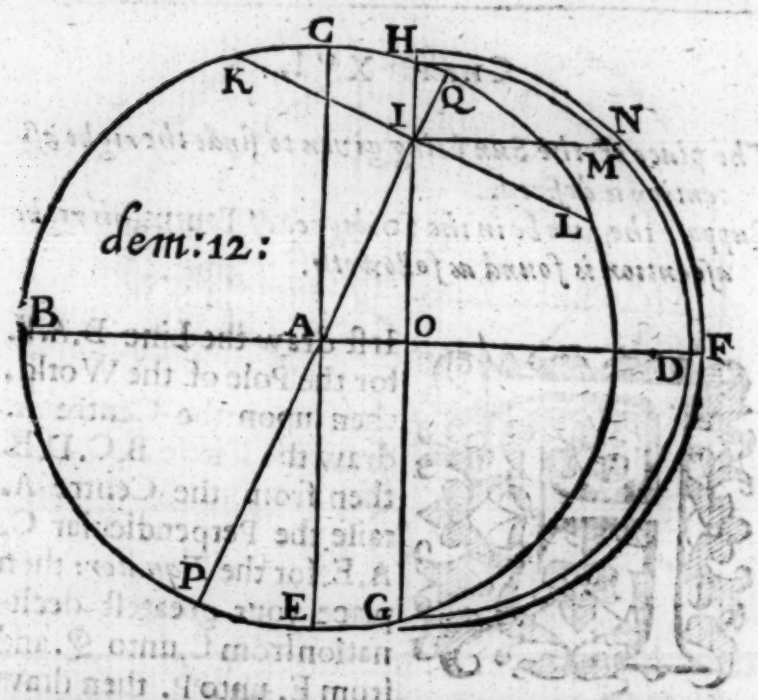
Chap. XVI.

The place of the Sun being given to finde the right ascention is desired.

Suppose the Sun be in the 20 degree of Taurus, *his right ascention is found as followeth.*

First draw the Line B.A.F. for the Pole of the World, then upon the Centre A. draw the Circle B.C.D.E. then from the Centre A. raise the Perpendicular C.A.E. for the *Equator:* then place your greatest declination from C. unto Q. and from E. unto P. then draw the line Q.A.P. which doth represent the Ecliptick line; then in regard the Sunne is in the 20 degree of *Taurus*, which is 40 degrees, from the head of *Cancer*, which 40 degrees place from Q. unto L. and unto K. then draw the line K.L. cutting the Ecliptick in I. then from the point I draw the Line H.I. parallell unto C.A.E. cutting the Pole of the World in O. then set one foot of your Compasses in O. and extend the other unto G. with which distance draw the Semicircle H.D.G. then opening your Compasses unto the Radius of the Scale, and upon the Centre O. likewise draw the Circle H.N.F.G. then draw the

line I.M. parallell unto A.O.D. cutting the Semicircle H.M.D.G. in M. then lay your Scale from the



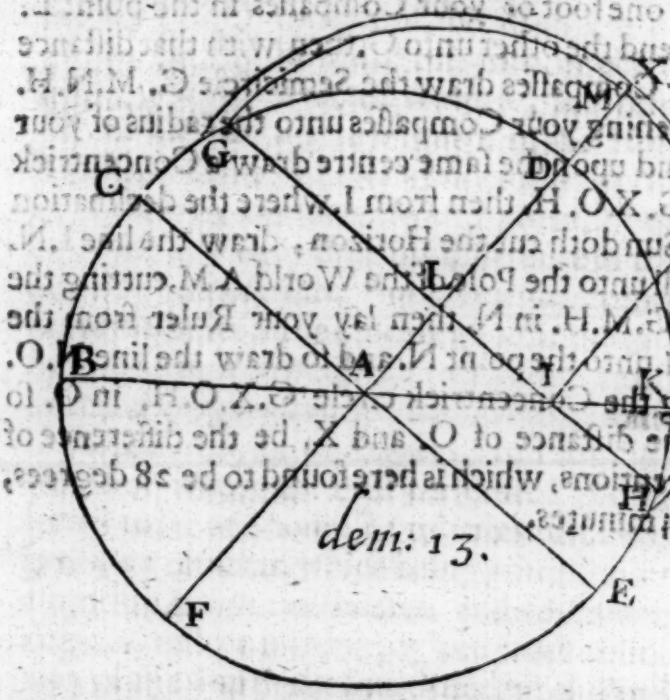
Centre O. unto the point M. and draw the Line N. M. cutting the Concentrick Circle in N. so shall the distance N.F. be the right ascention, which is here found to be 42 degrees, 27 minutes.

CHAP.

Chap. XVII.

The elevation of the Pole, and declination of the Sun, given to finde the difference of the ascentions.

The Poles elevation is 51 degrees 32 minutes, the declination of the Sun is 21 degrees.



FIrst draw the Line B. A. K. representing the Horizon, then upon the Centre A. draw the Circle B.C.D.E.F. Then from K. unto D. set the elevation of the Pole, which is 51 degrees, and 32 minutes: then from the point D. by the Centre A. draw the line D.A.F. representing the Pole o the World:

then from B. unto C. set the complement of the Poles elevation which is 38 degrees, and 26 minutes: then from C. by the Centre A. draw the line C.A.E. representing the Equinoctiall Line; then from C. unto G. and likewise from E. unto H. for the declination of the Sun, which is 21 degrees, then from G. unto H. draw the parallell of the Suns declination, cutting the Pole of the World in L. and the Horizon in I. then set one foot of your Compasses in the point L. and extend the other unto G. then with that distance of your Compasses draw the Semicircle G.M.N.H. then opening your Compasses unto the radius of your Scale, and upon the same centre draw a Concentrick circle, G.X.O.H. then from I. where the declination of the Sun doth cut the Horizon, draw the line I.N. parallell unto the Pole of the World A.M. cutting the circle G.M.H. in N. then lay your Ruler from the point I. unto the point N. and so draw the line N.O. cutting the Concentrick circle G.X.O.H. in O. so shall the distance of O. and X. be the difference of the ascentions, which is here found to be 28 degrees, and 54 minutes.

CHAP.

Chap. XVIII.

The right ascention of the Sun or Starre being given, together with the difference of their ascentions, to finde the oblique ascention.

THe right ascention of any point of the Heavens being known, the difference of the ascention is either to be added therunto, or else to be substracted from it, according as the Starre is situate in the Northern or Southern Signes. As for example, if the Sun be in any of these six Signes, *Aries, Taurus, Gemini, Cancer, Leo,* or *Virgo,* then the difference of the ascentions is to be substracted from the right ascention, and the remaynder is the oblique ascention. Suppose therfore the Sunne to be in the fourth degree of *Gemini,* where the right ascention is found to be foure houres, and 8 minutes, or 62 degrees, and the difference of ascention where the Pole is elevated 51 degrees, is found to be one houre 53 minutes other wise 28 degrees, 53 minutes, which being taken from the right ascention, leaves two houres, and 16 minutes, or 33 degrees, and 42 minutes, which is the oblique ascention of the Sun in the fourth degree of *Gemini.* But if the Sun be upon the South side of the Equinoctiall, either in *Libra, Scorpio, Sagitarius, Capricornus, Aquarius,* or *Pisces,* then the difference of the ascentions is to be added unto the right ascention, and the Product will be the oblique ascention. Suppose the fourth degree of *Sagitarius,* is given, for which signe and degree the oblique ascention of the Sunne is desi-

red,

red, his right aſcention being then found to be 242 degrees, or 16 houres, 8 minutes, the difference of the aſcentions is one houre, 53 minutes, or 28 degrees, 18 minutes: which being added unto the right aſcention, makes 18 houres, and one minute; or in degrees 270 degrees, and 18 minutes: which is the oblique aſcention of the Sun, when he is in the fourth degree of *Sagitarius*. And if you would finde the oblique deſcention, you muſt adde the difference of the aſcentions unto the right aſcention, when the Sun is in theſe ſix Signes, *Aries, Taurus, Cemini, Cancer, Leo, Virgo:* and contrariwiſe, when the Sunne is in the other ſix Signes, you muſt ſubſtract the difference from the right aſcention, and you ſhal have the oblique deſcention of the Sun, or any Starre, whoſe right aſcention and difference of aſcentions is known. But it is to be underſtood, that this manner of operations doth ſerve no longer than you are upon the North ſide of the Equinoctiall. For if the South Pole be elevated, the work is contrary: for ſo long as the Sun is in any of the Northern Signes, the difference of the aſcentions is to be added unto the right aſcention, to finde the oblique aſcention. And contrariwiſe, ſubſtracted to finde the oblique deſcention. Likewiſe if the Sun or Star be in the Southern Signes, then is the difference of aſcentions, ſubſtracted from the right aſcention, to finde the oblique aſcention, and added, to finde the oblique deſcention.

A Description of some peculiar things, *fit to be considered, by such as intend to practise the Art of Navigation, or Astronomie.*

THe Zenith is an imaginary point in the Heavens over our heads, making right Angles with the Horizon, as the Equinoctiall maketh with the Pole.

The *Nadir* is a prick in the Heavens under our feet, making right Angles with the Horizon under the earth, as the Zenith doth above; and therefore is opposite unto the Zenith.

The declination of the Sun, is the Arke of a Circle contained betwixt the Ecliptick and the Equinoctial, making right Angles with the Equinoctiall. But the declination of a Star, is the Arke of a Circle let fall from the Centre of a Star, perpendicularly unto the Equinoctiall.

The Latitude is the Arke of a Circle contained betwixt the Centre of any Star, and the Ecliptick Line

making right Angles with the Ecliptick, and counted either Northward, or Southward, according to the situation of the Star, whether it be neerer unto the North or South Pole of the Ecliptick.

The Latitude of a Town or Country, is the height of the Pole above the Horizon, or the distance betwixt the Zenith and the Equinoctiall.

The Longitude of a Star, is that part of the Ecliptick, which is contained betwixt the Stars place in the Ecliptick, and the beginning of *Aries* counting them from *Aries* according to the succession or order of the Signes.

The Longitude of a Towne or Countrey are the number of degrees, which are contained in the Equinoctiall, betwixt the Meridian that passeth over the Isles of *Azores*, (from whence the beginning of Longitude is accounted) Eastwards, and the Meridian that passeth over the Town or Country desired.

The Altitude of the Sun or Star, is the Arch of a circle contained betwixt the Centre of the Sun, or any Star, and the Horizon.

The amplitude is that part of the Horizon which is betwixt the two East or West points, & the point of the Compasse that the Sun or any Star doth rise or set upon.

Azimuthes are Circles, which meet together in the Zenith, and crosse the Horizon at right Angles, and serve to finde the point of the Compasse, which the Sun is upon at any houre of the day, or the Azimuth of the Sun or Star, is a part of the Horizon contained betwixt the true East or West point, and that Azimuth which passeth by the Centre of the same Star to the Horizon.

The right ascention of a Starre is that part of the Equi-

Equinoctiall that riseth or setteth with the Star, in a right Sphear, or in an oblique Sphear, it is that portion of the Equinoctiall, contained betwixt the beginning of *Aries*, and that place of the Equinoctiall, which passeth by the Meridian with the centre of the star.

The oblique ascention is a part of the Equinoctiall, contained betwixt the beginning of *Aries*, and that part of the Equinoctiall that riseth with the centre of a star, in an oblique Sphear.

The difference ascentionall, is the difference betwixt the right and oblique ascention: or it is the number of degrees contained betwixt that place of the Equinoctiall that riseth with a Centre of a starre, and that place of the Equinoctiall that commeth unto the Meridian, with the Centre of the same star.

Almicanterahs, are Circles drawne parallell unto the Horizon, one over another untill you come unto the Zenith: these are Circles that do measure the elevation of the Pole, or height of the Sun, Moon, or Stars above the Horizon, which is called the *Almicanter* of the Sun, Moon, or Star: the Arke of the Sun or stars *Almicanter*, is a portion of an Azimuth contained betwixt that *Almicanter* which passeth thorow the centre of the star, and the Horizon.

A generall Table for the Tides in all places.

The Moons age.	Houres and Minutes to be added.		The Moons age.	Houres and Minutes to be added.	
Dayes.	Degrees.	Minutes.	Dayes.	Degrees.	Minutes.
1	0	48	16	0	48
2	1	36	17	1	36
3	2	24	18	2	24
4	3	12	19	3	12
5	4	0	20	4	0
6	4	48	21	4	48
7	5	36	22	5	36
8	6	24	23	6	24
9	7	12	24	7	12
10	8	0	25	8	0
11	8	48	26	8	48
12	9	36	27	9	36
13	10	24	28	10	24
14	11	12	29	11	12
15	0	0	30	0	0

The use of the Table of the Tides.

FIrst it is to be understood, that by the swift motion of the first mover, the Moon and all the rest of the Stars and Planets, are turned about the World in 24 houres, upon which swift motion of the Moon, the daily motions of the Sea do depend, which motion of the Sea falleth not out always at one houre, the

the reaſon therof is, becauſe of the ſwift motion of Moon in regard ſhee goeth almoſt 13 degrees in 24 houres, and the Sun moveth ſcarce one degree: which gives every day 12 degrees, that the Moon commeth ſlower to any point in the Heaven than the Sunne: which 12 degrees makes 48 minutes of time for the difference of every full Sea, acco ding unto the middle motion of the Moon, which difference is here ſet down in this Table for every day of the Moons age. Therfore if you would know the full Sea at any place in the World, firſt you muſt know at what hour it is full Sea at the new or full Moon; which houres and minutes keep in mind, then ſeek the age of rhe Moon as is before taught, and with the number of her age enter this Table, under the title of the Moons age, and having found her age in the Table, againſt it you ſhall find the houres and minutes which are to be added unto the time that the Moon maketh full Sea in any place, and the whole number of houres and minutes is the time that the Moon maketh full Sea in that place upon the day deſired. As for example, I deſire to know the full Sea at *London* bridge upon the 13 of *July* 1624. the age of the Moon being found as before, is eight dayes, then in the Table I finde eight days, and againſt it 6 houres, and 24 minutes, which being added unto 3 houres, the full Sea upon the change day gives 9 a clock, 24 minutes for the time at the full Sea upon the 13 day of *July* 1624.

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